CLAIMS

I/We claim:

[c1] 1. A canard for an aircraft, comprising:

an airfoil portion having a first airfoil surface and a second airfoil surface facing opposite from the first airfoil surface, the airfoil portion being configured to be positioned external to an aircraft fuselage, the airfoil portion having a first portion configured to be exposed to a flow external to the fuselage, the airfoil portion further having a second portion movably coupled to the first portion, the second portion including a flight control surface; and

a connecting portion depending from the airfoil portion and having an attachment portion configured to attach to an aircraft internal to the aircraft fuselage, the connecting portion having a first load path positioned to carry a first load portion between the airfoil portion and the attachment portion, the connecting portion further having a second load path spaced apart from the first load path and positioned to carry a second load portion between the airfoil portion and the attachment portion, the connecting portion being rotatable about a rotation axis positioned between the first and second load paths.

[c2] 2. The canard of claim 1 wherein the second portion of the airfoil portion includes a deployable trailing edge device.

[c3] 3. The canard of claim 1 wherein the connecting portion includes:

a first arcuate bearing surface positioned at a first constant radial distance from the rotation axis and being rotatable with the connecting portion; and

a second arcuate bearing surface coupled to the first arcuate bearing surface and positioned at a second constant radial distance from the rotation axis, the second arcuate bearing surface being rotatable relative to the first arcuate bearing surface and the connecting portion.

[c4] 4. The canard of claim 1, further comprising an actuator coupled to the connecting portion to move the connecting portion relative to the fuselage.

[c5] 5. The canard of claim 1, further comprising an actuator coupled to the connecting portion to rotate the airfoil portion at a rate of about 20 degrees or more per second.

[c6] 6. The canard of claim 1, further comprising a ball screw actuator coupled to the connecting portion to rotate the connecting portion and the airfoil portion, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c7] 7. The canard of claim 1, further comprising an actuator coupled to the connecting portion to rotate the airfoil portion through about 40 degrees or more.

[c8] 8. The canard of claim 1 wherein the airfoil portion has a maximum chord length, and wherein the connecting portion has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c9] 9. The canard of claim 1 wherein the airfoil portion is a first airfoil portion configured to be positioned on a first side of the fuselage, and wherein the canard further comprises a second airfoil portion configured to be positioned on a second side of the fuselage opposite the first side of the fuselage, and wherein the connecting portion is positioned between the first and second airfoil portions and depends from both the first and second airfoil portions.

[c10] 10. The canard of claim 1 wherein the attachment portion is configured to attach to a non-pressurized portion of the fuselage.

[c11] 11. The canard of claim 1 wherein the connecting portion has a minimum cross-sectional area, and wherein the connecting portion and the airfoil portion are rotatable as a unit about a rotation axis passing through the minimum cross-sectional area.

[c12] 12. The canard of claim 1 wherein the second portion includes a trailing edge device movably coupled toward an aft part of the first portion, and wherein the airfoil portion further includes a leading edge device movably coupled toward a forward part of the first portion.

[c13] 13. The canard of claim 1 wherein the first portion of the airfoil portion is coupled to a first actuator to move at a first maximum rate, and wherein the second portion of the airfoil portion includes a trailing edge device coupled to a second actuator to move at a second maximum rate less than the first maximum rate.

[c14] 14. A canard for an aircraft, comprising:

an airfoil portion having a first airfoil surface and a second airfoil surface facing opposite from the first airfoil surface, the airfoil portion being configured to be positioned external to an aircraft fuselage, the airfoil portion having a first portion configured to be exposed to an external flow, the airfoil portion further having a second portion movably coupled to the first portion, the second portion including a flight control surface; and

a connecting portion depending from the airfoil portion and having an attachment portion configured to attach the connecting portion to an aircraft internal to the aircraft fuselage, the connecting portion having an interface region positioned to align with an external surface of the

aircraft fuselage, the connecting portion and the airfoil portion being rotatable as a unit about a rotation axis passing through the interface region.

[c15] 15. The canard of claim 14 wherein the second portion of the airfoil portion includes a deployable trailing edge device.

[c16] 16. The canard of claim 14, further comprising:

a first arcuate bearing surface positioned at a first constant radial distance from the rotation axis and being rotatable with the connecting portion; and

a second arcuate bearing surface coupled to the first arcuate bearing surface and positioned at a second constant radial distance from the rotation axis, the second arcuate bearing surface being rotatable relative to the first arcuate bearing surface and the connecting portion.

[c17] 17. The canard of claim 14, further comprising an actuator coupled to the connecting portion to rotate the airfoil portion at a rate of about 20 degrees or more per second.

[c18] 18. The canard of claim 14, further comprising a ball screw actuator coupled to the connecting portion to rotate the connecting portion and the airfoil portion, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c19] 19. The canard of claim 14 wherein the airfoil portion has a maximum chord length, and wherein the connecting portion has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c20] 20. The canard of claim 14 wherein the airfoil portion is a first airfoil portion configured to be positioned on a first side of the fuselage, and wherein the canard further comprises a second airfoil portion configured to be positioned on a second side of the fuselage opposite the first side of the fuselage, further wherein the connecting portion is positioned between the first and second airfoil portions and depends from both the first and second airfoil portions.

[c21] 21. The canard of claim 14 wherein the connecting portion has a minimum cross-sectional area, and wherein the connecting portion and the airfoil portion are rotatable as a unit about a rotation axis passing through the minimum cross-sectional area.

[c22] 22. A canard for an aircraft, comprising:

an airfoil portion having a first airfoil surface and a second airfoil surface facing opposite from the first airfoil surface, the airfoil portion being configured to be positioned external to an aircraft fuselage, the airfoil portion having a first portion configured to be exposed to an external flow, the airfoil portion further having a second portion movably coupled to the first portion, the second portion including a flight control surface; and

a connecting portion depending from the airfoil portion and having an attachment portion configured to attach to an aircraft internal to the aircraft fuselage, the connecting portion having a minimum cross-sectional area, the connecting portion and the airfoil portion being rotatable as a unit about a rotation axis passing through the minimum cross-sectional area.

[c23] 23. The canard of claim 22 wherein the second portion of the airfoil portion includes a trailing edge device.

[c24] 24. The canard of claim 22, further comprising an actuator coupled to the connecting portion to rotate the airfoil portion at a rate of about 20 degrees or more per second.

[c25] 25. The canard of claim 22, further comprising a ball screw actuator coupled to the connecting portion to rotate the connecting portion and the airfoil portion, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c26] 26. The canard of claim 22 wherein the airfoil portion has a maximum chord length, and wherein the connecting portion has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c27] 27. The canard of claim 22 wherein the airfoil portion is a first airfoil portion configured to be positioned on a first side of the fuselage, and wherein the canard further comprises a second airfoil portion configured to be positioned on a second side of the fuselage opposite the first side of the fuselage, and wherein the connecting portion is positioned between the first and second airfoil portions and depends from both the first and second airfoil portions.

[c28] 28. The canard of claim 22 wherein the airfoil portion includes:

a central portion fixed relative to the connecting portion; and

a trailing edge portion movable relative to the central portion and the connecting portion.

[c29] 29. A canard for an aircraft, comprising:

a first airfoil portion having a first airfoil surface and a second airfoil surface facing opposite from the first airfoil surface, the first airfoil portion being configured to be positioned external to an aircraft fuselage;

a second airfoil portion having a third airfoil surface and a fourth airfoil surface facing opposite from the third airfoil surface, the second

airfoil portion being configured to be positioned external to an aircraft fuselage; and

a connecting portion extending between the first and second airfoil portions and having first and second attachment portions configured to attach to an aircraft internal to the aircraft fuselage, the connecting portion having an intermediate region between the first and second attachment portions, the intermediate region being offset from an axis extending between the first and second attachment portions.

[c30] 30. The canard of claim 29, further comprising an actuator coupled to the connecting portion to rotate the airfoil portion at a rate of about 20 degrees or more per second.

[c31] 31. The canard of claim 29, further comprising a ball screw actuator coupled to the connecting portion to rotate the connecting portion and the airfoil portion, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c32] 32. The canard of claim 29 wherein the airfoil portion has a maximum chord length, and wherein the connecting portion has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c33] 33. The canard of claim 29 wherein the airfoil portion is a first airfoil portion configured to be positioned on a first side of the fuselage, and wherein the canard further comprises a second airfoil portion configured to be positioned on a second side of the fuselage opposite the first side of the fuselage, and wherein the connecting portion is positioned between the first and second airfoil portions and depends from both the first and second airfoil portions.

[c34] 34. The canard of claim 29 wherein the airfoil portion includes:

a central portion fixed relative to the connecting portion; and

a trailing edge portion movable relative to the central portion and the connecting portion.

[c35] 35. A canard for an aircraft, comprising:

an airfoil portion having a first airfoil surface and a second airfoil surface facing opposite from the first airfoil surface, the airfoil portion being configured to be positioned external to an aircraft fuselage;

a connecting portion depending from the airfoil portion and having an attachment portion configured to attach to an aircraft internal to the aircraft fuselage; and

an actuator operatively coupled to the connecting portion, the actuator being configured to rotate the connecting portion and the airfoil portion at a rate of about 20 degrees per second or more.

[c36] 36. The canard of claim 35 wherein the connecting portion has a first load path positioned to carry a first load portion between the airfoil portion and the attachment portion, the connecting portion further having a second load path spaced apart from the first load path and positioned to carry a second load portion between the airfoil portion and the attachment portion, the connecting portion being rotatable about a rotation axis positioned between the first and second load paths.

[c37] 37. The canard of claim 35 wherein the actuator is coupled to the connecting portion to rotate the airfoil portion at a rate of about 40 degrees or more per second.

[c38] 38. The canard of claim 35, further comprising a ball screw actuator coupled to the connecting portion to rotate the connecting portion and the airfoil portion, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c39] 39. The canard of claim 35, wherein the airfoil portion has a maximum chord length, and wherein the connecting portion has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c40] 40. The canard of claim 35 wherein the airfoil portion is a first airfoil portion configured to be positioned on a first side of the fuselage, and wherein the canard further comprises a second airfoil portion configured to be positioned on a second side of the fuselage opposite the first side of the fuselage, and wherein the connecting portion is positioned between the first and second airfoil portions and depends from both the first and second airfoil portions.

[c41] 41. The canard of claim 35 wherein the airfoil portion includes:

a central portion fixed relative to the connecting portion; and

a trailing edge portion movable relative to the central portion and the connecting portion.

[c42] 42. An aircraft, comprising:

a fuselage having a first side and a second side opposite the first side;

a wing attached to the fuselage;

a canard attached to the fuselage forward of the wing, the canard including:

a first airfoil positioned on the first side of the fuselage, a central portion and a trailing edge portion movable relative to the central portion;

a second airfoil positioned on the second side of the fuselage;

a connecting member coupled to the first and second airfoils and passing through the fuselage, the connecting member having a first load path positioned to carry a first load portion between the first and second airfoils, the connecting member further having a second load path spaced apart from the first load path and positioned to carry a second load portion between the first and second airfoils, the connecting member being

rotatable about a rotation axis relative to the fuselage to rotate the first and second airfoils relative to the fuselage, the rotation axis being positioned between the first and second load paths.

[c43] 43. The aircraft of claim 42 wherein the first and second airfoil portions each have a central portion and a trailing edge portion movable relative to the central portion.

[c44] 44. The aircraft of claim 42 wherein the connecting member includes first and second attachment portions configured to attach to an aircraft internal to the aircraft fuselage, the connecting member having an intermediate region between the first and second attachment portions, the intermediate region being offset from an axis extending between the first and second attachment portions.

[c45] 45. The aircraft of claim 42, further comprising an actuator coupled to the connecting member to rotate the airfoil portion at a rate of about 20 degrees or more per second.

[c46] 46. The aircraft of claim 42, further comprising a ball screw actuator coupled to the connecting member to rotate the connecting member and the airfoils, wherein the ball screw actuator is configured to rotate at a speed of about 900 rpm or more.

[c47] 47. The aircraft of claim 42, wherein at least one of the airfoils has a maximum chord length, and wherein the connecting member has a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c48] 48. The aircraft of claim 42 wherein the fuselage includes a passenger cabin portion, and wherein the connecting portion is attached to the fuselage external to the passenger cabin portion.

[c49] 49. An aircraft, comprising:

fuselage means for carrying a payload;

wing means for lifting the fuselage means; and

canard means for controlling pitch axis motion of the fuselage means, the canard means being positioned forward of the wing means and including:

first airfoil means for controlling the pitch axis motion, the first airfoil means being positioned on a first side of the fuselage;

second airfoil means for controlling the pitch axis motion, the second airfoil means being positioned on a second side of the fuselage;

connecting means for connecting the first and second airfoil means, the connecting means passing through the fuselage means and having a first load path positioned to carry a first load portion between the first and second airfoil means, the connecting means further having a second load path spaced apart from the first load path and positioned to carry a second load portion between the first and second airfoil portions, the connecting portion being rotatable about a rotation axis relative to the fuselage to rotate the first and second airfoils relative to the fuselage means, the rotation axis being positioned between the first and second load paths.

[c50] 50. The aircraft of claim 49 wherein each of the airfoil means includes a first portion fixed relative to the connecting means, and wherein each of the airfoil means includes a second portion movable relative to the first portion, the second portion including a flight control surface.

[c51] 51. A method for installing an aircraft canard, comprising:

positioning an airfoil portion of the canard external to an aircraft fuselage, the airfoil portion having a first portion configured to be exposed to

an external flow, the airfoil portion further having a second portion movably coupled to the first portion, and the second portion including a flight control surface;

positioning a connecting portion of the canard internal to the fuselage, the connecting portion having an attachment portion, the connecting portion further having a first load path positioned to carry a first load portion between the airfoil portion and the attachment portion, the connecting portion still further having a second load path spaced apart from the first load path and positioned to carry a second load portion between the airfoil portion and the attachment portion; and

attaching the attachment portion to the aircraft internal to the aircraft fuselage with the connecting portion being rotatable about a rotation axis positioned between the first and second load paths.

[c52] 52. The method of claim 51 wherein the fuselage includes a passenger cabin, and wherein attaching the attachment portion includes attaching the attachment portion to an unpressurized portion of the fuselage external to the passenger cabin.

[c53] 53. The method of claim 51 wherein the connecting portion has a minimum cross-sectional area and wherein attaching the attachment portion includes attaching the attachment portion with the rotation axis intersecting the minimum cross-sectional area.

[c54] 54. The method of claim 51, further comprising coupling an actuator between the connecting portion and the fuselage.

[c55] 55. The method of claim 51, further comprising coupling a ball screw actuator between the connecting portion and the fuselage.

[c56] 56. The method of claim 51 wherein the airfoil portion has a maximum chord length, and wherein attaching a connecting portion includes attaching a connecting portion having a chordwise dimension of from about 5% to about 15% of the maximum chord length.

[c57] 57. The method of claim 51 wherein attaching the canard includes attaching a canard having a second portion that includes a deployable trailing edge device.

[c58] 58. The method of claim 51 wherein the connecting portion has a minimum cross-sectional area, and wherein the method includes connecting the attachment portion to the fuselage with the rotation axis passing through the minimum cross-sectional area.

[c59] 59. A method for installing an aircraft canard, comprising:

positioning an airfoil portion of the canard external to an aircraft fuselage, the airfoil portion having a first portion configured to be exposed to an external flow, the airfoil portion further having a second portion movably coupled to the first portion, and the second portion including a flight control surface;

positioning a connecting portion of the canard internal to the fuselage, the connecting portion having an attachment portion;

positioning an interface region of the canard in alignment with an external surface of the fuselage; and

attaching the attachment portion to the aircraft internal to the aircraft fuselage with the connecting portion being rotatable about a rotation axis passing through the interface region.

[c60] 60. The method of claim 59 wherein the fuselage includes a pressurized passenger cabin, and wherein attaching the attachment portion includes attaching

the attachment portion to an unpressurized portion of the fuselage external to the passenger cabin.

[c61] 61. The method of claim 59 wherein attaching a canard includes attaching a canard having:

a central portion fixed relative to the connecting portion; and

a trailing edge portion movable relative to the central portion and the connecting portion.

[c62] 62. A method for operating an aircraft canard, comprising:

activating an actuator operatively coupled to an airfoil portion of the canard via a connecting portion, the actuator being positioned internal to a fuselage of the aircraft, the airfoil portion being positioned external to the fuselage;

rotating the connecting portion of the canard; and

rotating the airfoil portion of the canard via the connecting portion at a rate of about 20 degrees or more per second.

[c63] 63. The method of claim 62 wherein the canard includes a central portion fixed relative to the connecting portion and a trailing edge portion movable relative to the central portion and the connecting portion, and wherein the method further comprises moving the trailing edge portion relative to the central portion.

[c64] 64. The method of claim 62 wherein activating an actuator includes activating a ball-screw actuator.